AUTOMATION OF PRODUCTION

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AUTOMATION OF THERMOTECHNICAL MACHINERY IN GLASS PRODUCTION

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The operating principles of automated control system for glass-melting furnaces and drums for drying sand and dolomite are described.

One of the new directions in the activity of the Stromizmeritel' JSC is the development and production of automated control systems for glass-melting furnaces (ACS GF), glass melt feeders, drying drums, and other thermotechnical machines. There are different approaches to constructing such control systems [1 – 3] and different criteria for selecting their hardware and software.

The ASC GF developed at the Stromizmeritel' JSC includes a single-board PC-compatible foreign-production controller as the control unit and software represented by integrated SCADA/HMI and SOFTLOGIC system TRACE MODE system.

The control system has two levels (Fig. 1) and consists of personal computer *1*, PC-compatible controller *2* with input and output modules, optosimistor power modules *3*, secondary displaying transformers *4*, electric drive control panels *5*, primary sensors *6*, and executive mechanisms *7*.

The lower level of the ACS GF, similarly to most known control systems, has the following targets: control of the glass melt level, atmospheric pressure in the glass-melting furnace, the temperature regime of the furnace and glass melt feeders, fuel flow rate correction based on temperature in the furnace, fuel : air ratio, and automatic transfer of the flame direction. The melt level control contour consists of an optical level gage and the batch loader control system.

The variation of the output of plunger loaders is performed using industrially produced frequency-regulated transformers, which provide continuous feeding of the batch and decrease fluctuations of the glass melt level. In using loaders with a vibration feeder, a rotary table, and a pusher, the intensity of batch charging into the furnace is regulated by a transformer developed at the Stromizmeritel' JSC, which compensates for input voltage fluctuations. The mechanisms of this loader can be controlled in the manual, semiautomatic, or automatic modes. In the semiautomatic mode, the rotary table and the pusher operate according to a preset cyclogram and the vibration feeder output is specified manually. In the automatic mode all executive mechanisms are switched on by the controller commands. The rotary tables of the loader (if there are more than one) can change the direction of the batch feed both synchronically and in antiphase. Differentiated charging is possible as well, where the output of individual loaders differs and is regulated depending in the glass melt output and the batch distribution over the melting zone of the furnace.

The temperature regime is stabilized using a two-contour fuel rate control system allowing for its correction based on the gas space temperature in the furnace. In the absence of the control thermocouple (for instance, if it is being replaced or fails), the regulation regime without correction is applied. In this case one can specify the minimum and maximum fuel rate.

The air flow rate is regulated using mechanical gates with an electric drive or by changing the rotational speed of the fan motor supplying air for combustion.

The reversal of the flame direction is performed with time or based on the temperature difference between the upper checkerwork rows on the left and right regenerators. If a preset temperature difference does not reach a certain value in a certain time period, the mechanisms of fuel and air transfer are switch on after the lapse of this time. All operations on flame reversal can be performed in the manual, semiautomatic, or automatic modes and also in the "anticipated reversal" mode by the operator pressing the respective button on the control panel.

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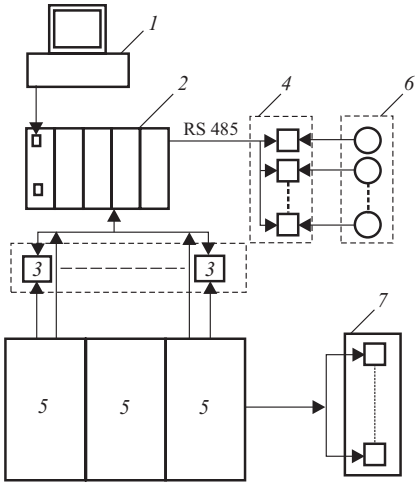

Fig. 1. Block-scheme of ACS GF.

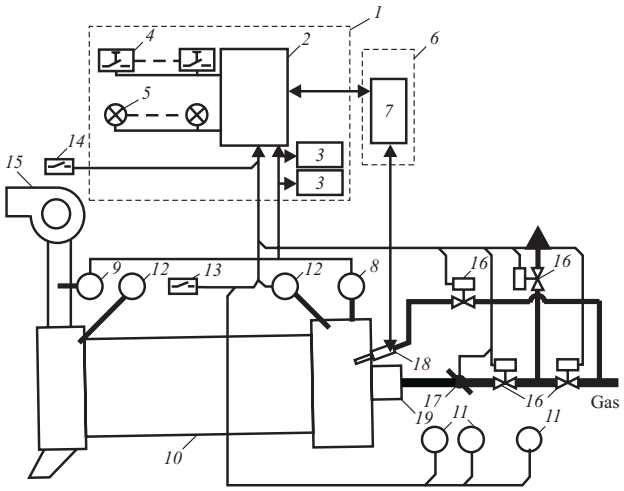

Fig. 2. Block-scheme of ACS DD.

The upper level of the ACS GF including the automated workplace based on a personal computer fulfills the following functions:

– monitoring and setting technological parameters (temperature, pressure, rarefaction, glass melt level, etc.);

– graphic display of information on the operation of the object;

– manual remote control and emergency signals;

– storing accumulated data on the hard drive or the PC, protocols of events, and printing reports.

The software complex includes software for the controller and for the automated workplace of the glass-melting furnace operator.

The software for the operator's workplace includes the executive program module of the real time monitor (RTM) for 1024 control points; project files stored on the PC hard drive needed for the RTM operation; MS Windows 2000 Workstation; NetBEUI, TCP/IP network protocols, and the local documentation server. The main workplace function are fulfilled by the RTM with the project loaded in it, whereas the documentation server is intended for automatic printing of the work shift journal, plots, reports and other archive data. The periodicity of reports is set by the operator. The SAC GF operator having administrative rights can switch on or off the data archiving system.

The software of the controller directly controlling the executive mechanism of the glass-melting furnace includes a microRTM module for 4096 control points, files needed for the microRTM operation, a driver for exchanging microRTM data between the chips of the interface with the furnace, MS-DOS 6.X operation system, and Microsoft Network Client for MS-DOS.

A PC-compatible controller is used at the lower level of the ACS GF, because it can be programmed not only using standard program languages, but also more "flexible" high-level languages as SI and Pascal. The element basis of this controller is similar to the element basis of the majority of known controllers, such as Siemens, Omron, Telemecanique, and Allen Bradley, but this single-board controller is less expensive and yet performs the same functions.

All this has predetermined the choice of the controller and made it possible to create an effective and competitive system for controlling the glass-melting furnace, which has been installed at several factories in the glass industry.

The automated control system for drying drums (ACS DD) developed by the Stromizmeritel' JSC is based on another controller, namely TWIDO (Telemecanique trademark), The use of this controller has made it possible to combine several functions in a single device:

– automatic safety system for gas equipment and control of the temperature regime of drying sand or dolomite;

– control of airtightness of gas valves, gas pressure, rarefaction, smoke exhaust operation, etc.;

– ignition and flame control;

– indication of the state of executive mechanisms and emergency alarm signals;

– storing thermal regime parameters of the drying process.

The ACS DD (Fig. 2) contains panel *1* for temperature regime regulation and gas equipment safety devices consisting of controller *2*, digital indication blocks *3*, manual control tools *4*, and signal elements *5*; panel *6* for automatic ignition and flame control *7*; temperature sensors *8*, *9* in the charge and discharge chambers of the drying drum *10* ; pressure *11* and rarefaction *12* gages; block contacts *13*, *14* of the magnetic starters of the drying drum and the smoke exhauster *15*; electromagnetic valves *16* for gas supply and blow-through of gas pipelines; control valve *17*; ignition burner *18*, and main (injector) burner *19*.

The equipment used as gas-shutting-off devices, regulators, and control sensors is made by Kromschroder (Germany). The system operates as follows, Before each start of the drying drum, the system performs the ventilation of the combustion chamber, blows through the gas pipeline, and

checks the airtightness of the main electromagnetic valves and rarefaction. After the ignition burner is lit up, the main burner is automatically lit up at the minimum power. The presence of flame is registered using an electrode made of cantal A1 (fechral), which is less expensive than an ultraviolet sensor and has as long service life.

The thermal regime of drying of materials is implemented by a controller regulator that controls the control valve depending on the temperature of the exhaust flue gases. By using two-wire burners, one can modify the rotational speed of the electric motor of the blow fan to ensure the prescribed fuel : air ratio.

To integrate the glass-melting furnace control system into a higher level system, for instance, the automated control system for batch preparation, data transfer is provided using standard current signals of 4 – 20 mA or through an industrial network such as Modbus, Profibus, CAN Open, etc.

The ACS DD has been implemented at the Sergiev Posad Glass Works and is being prepared for installation at a few other factories in Russia, Uzbekistan, Armenia, and Azerbaidzhan. By the customers' choice the control systems for the drying drum and the glass-melting furnace can be both equipped with industrially made controller produced by Siemens, Omron etc.

REFERENCES

1. L. V. Reinish, "Automatic control system for glass-melting furnace," *Steklo Mira*, No. 4, 66 – 67 (2004).
2. A. A. Dobrolyubov and A. I. Figurkin, "Development and implementation of automatic control systems for thermal machines at glass works," *Steklo Keram.*, No. 8, 43 (2000).
3. S. S. Il'ichev and V. I. Laptev, "Automation of glass production," *Steklyannaya Tara*, No. 3, 5 (2001).